Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jean Blachot	ENSDF	1-Jul-2008

Q(β^-)=1646 *3*; S(n)=7271.41 *17*; S(p)=6523.1 *24*; Q(α)=−3076 *4* 2012Wa38
Note: Current evaluation has used the following Q record.
Q(β^-)=1650 *7*; S(n)=7271.41 *17*; S(p)=6523 *3*; Q(α)=−3077 *5* 2003Au03
Additional high energy transitions reporting in (n,γ) could be primary transitions defining additional levels above 1200 keV.

^{108}Ag Levels

For unplaced transitions see (p,nγ) and (n,γ) E=th.

Cross Reference (XREF) Flags

A	^{108}Ag IT decay (438 y)	E	^{107}Ag(n,γ) E=2,24 keV: av res
B	^{107}Ag(n,γ) E=th: secondary	F	^{107}Ag(d,p)
C	^{107}Ag(n,γ) E=thermal: primary	G	^{108}Pd(p,nγ)
D	^{107}Ag(n,γ) E=16.3 eV	H	(HI,xnγ)

E(level)†	J$^\pi$&	$T_{1/2}$	XREF	Comments
0.0	1$^+$	2.382 min *11*	ABCDE G	%β^-=97.15 *20*; %ε+%β^+=2.85 *20* μ=2.6884 *7* J$^\pi$: atomic beam (1976Fu06). π: E1 γ from 2$^-$. $T_{1/2}$: from wt avg (Lweight program) of 2.353 min *9* (1992KaZM), 2.37 min *1* (1974Ry01), 2.38 min *3* (1971Jo07), 2.41 min *2* (1965Eb01), 2.42 min *2* (1960Wa10), 2.43 min *5* (1958Gu09). Earlier measurements: 1962Th12, 1957Se19, 1948Pe03, 1948Mo33. μ: from radiative detection of NMR (1989Ra17). E(level): probable configuration= $((\pi\ 1g_{9/2})^{-3}_{7/2+}(\nu\ 2d_{5/2}))1^+$.
79.1401 *23*	2$^-$	1.2 ns *4*	ABC EFG	J$^\pi$: E1 γ to 1$^+$. M4 γ from 6$^+$. π from L(d,p)=2. $T_{1/2}$: from $\gamma\gamma$(t) in (n,γ). $T_{1/21/2}$<1 ns from ceγ(t) in ^{108}Ag it decay.
109.466 *7*	6$^+$	438 y *9*	AB H	%IT=8.7 *9*; %ε+%β^+=91.3 *9* Q=+1.32 *7*; μ=3.580 *20* J$^\pi$: optical hyperfine structure pattern (1975Fi07). π from M4 γ to 2$^-$. $T_{1/2}$: from 2004Sc04. 2004Sc04 has followed the decay by using a ionization chamber for about 20 years.Others: 310 y *132* (1969Vo11), 127 y *21*(1970Ha32), 418 y *15* (1992Sc25). μ: : from optical interference spectroscopy of hyperfine structure (1989Ra17). Q: from 1984Be53. Jπ:$\Delta\langle r^2\rangle$(^{108}Ag−^{107}Ag)= 0.022 *3* fm^2, (^{110}Ag-^{108}Ag)=0.152 *10* fm^2 (1975Fi07) where the ^{110}Ag level referred to is the isomer. E(level): probable configuration= $((\pi\ 1g_{9/2})^{-3}_{7/2+}(\nu\ 2d_{5/2}))6^+$.
155.900 *7*	5$^+$,6$^+$		B	J$^\pi$: see 598 level.
193.073 *3*	1$^+$	<0.5 ns	BCDE G	J$^\pi$: E1 γ to 2$^-$. Fed in (n,γ) from 0$^-$.
206.614 *3*	2$^+$	<0.2 ns	BC E G	J$^\pi$: M1 γ to 1$^+$. $\gamma(\theta)$ in (p,nγ).
215.382 *4*	3$^+$	45.8 ns *7*	B FGH	μ=+3.888 *15* (1989Ra17) J$^\pi$: E1 γ to 2$^-$. $\gamma(\theta)$ and excitation function in (p,nγ). $T_{1/2}$: from p,γ(t) in (p,nγ). Other: 50 ns *3* (n,γ). μ: from $\gamma(\theta$,H,t) in (p,nγ).
286.7?‡ *5*			G	
290.18 *23*			H	
294.560 *3*	2$^+$	<0.14 ns	BC E G	J$^\pi$: M1 γ's to 1$^+$ and 2$^+$. $\gamma(\theta)$ in (p,nγ).
324.497 *4*	3$^+$		B G	J$^\pi$: M1 γ to 2$^+$. $\gamma(\theta)$ in (p,nγ).
331.6 *5*			G	

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Adopted Levels, Gammas 2004Ti06

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. H. Kelley, C. G. Sheu and J. L. Godwin, et al.	NP A745 155 (2004)	31-Mar-2004

Q(β^-)=556.8 *4*; S(n)=6812.28 *5*; S(p)=19636.39 *20*; Q(α)=−7409.52 *10* 2012Wa38
Note: Current evaluation has used the following Q record.
Q(β^-)=556.0 *6*; S(n)=6812.2 *6*; S(p)=19636.6 *19*; Q(α)=−7413.3 *9* 2003Au03

^{10}Be Levels

Cross Reference (XREF) Flags

A	^{6}Li(^{6}He,α^6He),(^{6}He,^{10}Be)	N	^{9}Be(^{11}Be,^{10}Beγ),(^{11}B,^{10}B)	Others:	
B	^{7}Li(t,γ),(t,n),(t,p),(t,t)	O	^{9}Be(^{14}N,^{13}N)	AA	^{12}C(^{6}He,^{10}Be)
C	^{7}Li(^{3}He,π^+)	P	^{10}Be(p,p′),(d,d)	AB	^{12}C(^{6}Li,^{8}B)
D	^{7}Li(α,p)	Q	^{10}B(γ,π^+)	AC	^{12}C(^{9}Be,^{11}C)
E	^{7}Li(^{7}Li,α),(^{7}Li,$\alpha\gamma$)	R	^{10}B(μ^-,ν)	AD	^{12}C(^{10}Be,X)
F	^{9}Be(n,γ) E=thermal	S	^{10}B(π^-,γ)	AE	^{12}C(^{11}B,^{13}N)
G	^{9}Be(n,n),(n,n′),(n,2n)	T	^{10}B(n,p),(d,2p)	AF	^{12}C(^{12}Be,α^6He)
H	^{9}Be(n,p),(n,d),(n,t)	U	^{10}B(t,^{3}He)	AG	^{12}C(^{12}C,^{10}Be)
I	^{9}Be(p,π^+)	V	^{10}B(^{7}Li,^{7}Be)	AH	^{12}C(^{15}N,^{17}F)
J	^{9}Be(d,p),(d,pγ)	W	^{11}Li β^-n decay	AI	^{13}C(t,^{6}Li)
K	^{9}Be(α,^{3}He)	X	^{11}Be(p,d)	AJ	^{14}C(^{18}O,^{22}Ne)
L	^{9}Be(^{7}Li,^{6}Li),(^{8}Li,^{7}Li)	Y	^{11}B(d,^{3}He)	AK	^{11}B(t,$\alpha\gamma$)
M	^{9}Be(^{9}Be,^{8}Be)	Z	^{11}B(^{7}Li,^{10}Beγ)	AL	^{9}Be(n,γ) res

E(level)	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	0$^+$	1.51×10^6 y *4*	AB DEF IJKLMNOPQ STUVWXYZ	XREF: Others: AA, AB, AC, AE, AG, AH, AI, AJ %β^-=100 T=1 T$_{1/2}$: from weighted average of T$_{1/2}$=1.51 Ma 6 (Hofmann et al., Nucl. Instrum. Meth. Phys. Res. *β* 24-25 (1987) 276), T$_{1/2}$=1.53 Ma 5% (1993Mi26), and T$_{1/2}$=1.48 Ma 5% (1993Mi26).
3368.03 *3*	2$^+$	125 fs *12*	ABCDEF IJKLMNOPQRSTUVWXYZ	XREF: Others: AA, AB, AC, AE, AG, AH, AI, AJ %IT=100 T=1 Γ_γ=3.66×10^{-3} eV *35* B(E2)=52 e^2 fm^4 6 (1987Ra01). E(level): from ^{9}Be(n,γ) (1983Ke11). Other value: 3368.34 keV *43* (1999Bu26).
5958.39 *5*	2$^+$	<55 fs	D F JKLM P R TU W Y	XREF: Others: AB, AE, AG, AH, AI %IT=100 T=1 E(level): from ^{9}Be(n,γ) (1983Ke11). Other value: 5958.3 keV *3* (1969Al17).
5959.9 *6*	1$^-$		D JKLMNO T Y	XREF: Others: AB %IT=100 T=1 E(level): from ^{9}Be(d,p) (1969Al17).
6179.3 *7*	0$^+$	0.8 ps *+3−2*	D J W	%IT≈100 T=1 decay: May also decay by pair production. E(level): from ^{9}Be(d,p) (1969Al17). Other value: 6070 keV *130* (1973Da09).

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Khalifeh Abusaleem	NDS 112, 2129 (2011)	31-Dec-2010

Q(β^-)=124.6 *14*; S(n)=6.30×10^3 *SY*; S(p)=4832 *6*; Q(α)=5523.4 *21* 2012Wa38
Note: Current evaluation has used the following Q record.
124.0 *14* 6300 syst 4832 *5* 5525.0 *23* 2009AuZZ,1995Au04.
Estimated ΔS(n)=71 (2011AuZZ).
Q(β^-)=124.0 *14*; S(n)=6301 *SY*; S(p)=4832 *5*; Q(α)=5525.0 *23* 2011AuZZ

Calculations, compilation:
α decay, deformation parameters: 1996St14, 1996St28.
α decay, $T_{1/2}(\alpha)$: 1993Bu09, 1992Bu03.
Ground state properties: 1997Mo25, 1997Mo29.
Pion decay: 1988Io05.
Single-particle Nilsson levels: 2004Pa04, 1994Cw02.

2004Pa04 calculate the following single-particle level sequence: 0.05 MeV 7/2[633], 0.25 MeV 5/2[642], 0.35 MeV 1/2[400], 0.51 MeV 3/2[402], 0.54 MeV 1/2[521].
1994Cw02 calculate the following single-particle level sequence: g.s. 3/2[521], 0.15 MeV 7/2[633], 0.34 MeV 5/2[642], 0.44 MeV 1/2[660], 0.63 MeV 3/2[651], 0.82 MeV 5/2[523].

Measured relative L and M x-ray intensities: 1990Po14.
See 1975Er01 for rotational band assignments.

^{249}Bk Levels

Cross Reference (XREF) Flags

A ^{249}Cm β^- decay
B ^{253}Es α decay (20.47 d)
C ^{248}Cm(α,t),(^{3}He,d)
D Coulomb excitation

E(level)[c]	J$^\pi$	$T_{1/2}$[d]	XREF	Comments
0.0[†]	7/2$^+$	330 d *4*	ABCD	%α=0.00145 *8*; %β^-=99.99855 *8*; %SF=47×10^{-9} *2* μ=2.0 *4* (1989Ra17,1972Bo67); Q=5.79 (1996FiZX) E(level): 5.93 *11* (1982Be12). J$^\pi$: electron paramagnetic resonance (1967Wo01); π, configuration from favored α decay from ^{253}Es. $T_{1/2}$: from 1985Po26. Others: 325 d *7* (1974Gl10), 314 d *8* (1957Ea01). %α: from α/β^-=1.45×10^{-5} *8* (1969Mi08). Other: 2.2×10^{-5} *3* (1957Ea01). %SF: from $T_{1/2}$(SF)=1.87×10^9 y *9* (1969Mi08). Other:≥1.4×10^9 y (1957Ea01). μ: other: 5.1 *7* (1969Wo07) believed to be based on invalid assumptions (1972Bo67), +3.45 *10* (from Coul.ex. 1982Be12). Q: others: 4.7 *10* (1969Wo07), Q=5.79.
8.777[‡] *14*	3/2$^-$	0.3 ms	ABC	J$^\pi$: log *ft*=5.9 from 1/2$^{(+)}$ ^{249}Cm limits J$^\pi$ to 1/2±, 3/2±; $T_{1/2}$ is consistent with M2 transition to g.s., ΔL≥3 ruled out (B(E3)(W.u.)≈540 (RUL=100), B(M3)(W.u.)≈7000 (RUL=10)).
39.622[‡] *13*	(5/2$^-$)		ABC	J$^\pi$: M1+E2 γ to (3/2$^-$) level; member rotational band.
41.805[†] *8*	9/2$^+$	9 ps *2*	BCD	J$^\pi$: M1+E2 γ to 7/2$^+$ level; band structure.
82.599[‡] *13*	7/2$^-$		ABC	J$^\pi$: E2 γ to (3/2$^-$) level, M1+E2 γ to (5/2$^-$) level; member rotational band.
93.759[†] *8*	11/2$^+$	5 ps *1*	B D	J$^\pi$: E2 γ to 7/2$^+$ g.s., M1+E2 γ to 9/2$^+$ level; rotational structure.

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	S. Kumar(a), J. Chen(b) and F. G. Kondev	NDS 137, 1 (2016)	31-May-2016

$Q(\beta^-)$=−2016 *4*; S(n)=7323.1 *18*; S(p)=8186.6 *28*; $Q(\alpha)$=−2511.5 *19* 2012Wa38
Additional information 1.

^{109}Cd Levels

Cross Reference (XREF) Flags

A	^{109}In ε decay	F	^{100}Mo(^{13}C,4nγ)
B	^{109}Cd IT decay (11.8 μs)	G	^{108}Pd(α,3nγ)
C	^{109}Cd IT decay (10.6 μs)	H	^{109}Ag(p,nγ)
D	^{96}Zr(^{16}O,3nγ)	I	^{110}Cd(d,t)
E	^{96}Zr(^{18}O,5nγ)		

E(level)[†]	J^π	$T_{1/2}$[i]	XREF	Comments
0.0	5/2$^+$	461.9 d *4*	ABCDEFGHI	%ε=100 μ=−0.8278461 *15*; Q=+0.604 *25* J^π: optical-double resonance (1976Fu06); direct ε to 7/2$^+$ level in ^{109}Ag; L(d,t)=2. $T_{1/2}$: using the Limitation of Relative Statistical Weight method and 462.3 d *8* (2014Un01), 462.36 d *33* and 461.92 d *76* (2011Va02), 459.6 d *17* (2004Sc04), 460.2 d *4* (1997Ma75), 463.1 d *4* (1982La25), 461.9 d *3* (1981Va11), 450 d *5* (1968Re04), 459 d *6* (1968Ea01),453 d *2* (1965Le06) and 470 d *8* (1950Gu54). Other: 330 d (1947Br05). Values of 463.2 *6* (1982HoZJ), 463.26 *63* (1992Un01,2002Un02) and 462.6 *6* (2012Fi12) are superseded by 2014Un01. μ: from 2014StZZ, based on 1972Sp09 and 1963By02 data. Q: from 2013Yo02 by collinear laser spectroscopy. Other: +0.69 *7* from 1969La06 by optical double resonance. configuration: a mixture between $\nu d_{5/2}$ and $\nu g_{7/2}$ orbitals.
59.60 *7*	1/2$^+$	11.8 μs *16*	AB HI	%IT=100 J^π: L(d,t)=0; 59.6γ E2 to 5/2$^+$. $T_{1/2}$: weighted average of 11.7 μs *18* (1968Iv02) and 12 μs *3* (1956Pe56) in ^{109}Cd IT decay. configuration: $\nu s_{1/2}$.
203.40 *5*	7/2$^+$	36 ps *+6−1*	A CDEFGHI	J^π: L(d,t)=4, 203.5γ M1 to 5/2$^+$. $T_{1/2}$: from microwave modulation of beam and lens spectrometer (1969Be37). configuration: $\nu g_{7/2}$.
347.51 *6*	5/2$^+$		A HI	J^π: L(d,t)=2, 288.1γ E2 to 1/2$^+$.
426.42 *6*	5/2$^+$		A HI	J^π: L(d,t)=2; 426.3γ M1+E2 to 5/2$^+$; 679.5γ from 9/2$^+$.
463.10[‡] *11*	11/2$^-$	10.6 μs *4*	A CDEFGHI	%IT=100 Q=−0.92; μ=−1.096 *2* J^π: L(d,t)=5, 259.7γ M2 to 7/2$^+$. $T_{1/2}$: weighted average of 10.4 μs *6* (1964Br27), 10.4 μs *10* (1966Mc06), 10.8 μs *16* (1968Iv02), and 10.8 μs *7* in 1975Me22. μ: from a measurement by the Stroboscopic Observation of Perturbed Angular Distribution (SOPAD) method (2014StZZ). Q: from 1978Sp09 by the Time Dependent Perturbed Angular Distribution (TDPAD) method. Value measured relative to Q for ^{107}Cd and ^{111}Cd and by assuming that the magnitude of Q follows the relative $h_{11/2}$ shell filling with an increasing neutron number. configuration: $\nu h_{11/2}$.

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jean Blachot	NDS 111, 1471 (2010)	1-May-2009

Q(β^-)=322.6 *8*; S(n)=6538.8 *6*; S(p)=9748.5 *25*; Q(α)=−3861.5 *12* 2012Wa38
Note: Current evaluation has used the following Q record.
Q(β^-)=322 *1*; S(n)=6540.1 *6*; S(p)=9750 *3*; Q(α)=−3868 *3* 2003Au03,2009AuZZ
Neutron resonance parameters can be found in 1981MuZQ.
α: Additional information 1.

^{113}Cd Levels

Cross Reference (XREF) Flags

A	^{113}Ag β^- decay (5.37 h)	F	^{113}Cd(p,p'),(p,p'γ)	K	^{110}Pd(α,nγ)
B	^{113}Ag β^- decay (68.7 s)	G	^{113}Cd(d,d')	L	^{176}Yb(^{28}Si,Fγ)
C	^{113}Cd IT decay (14.1 y)	H	Coulomb excitation	M	^{173}Yb(^{24}Mg,Fγ)
D	^{112}Cd(n,γ) E=res	I	^{113}Cd(n,n'γ)	N	^{112}Cd(pol d,p)
E	^{112}Cd(d,p), ^{114}Cd(d,t)	J	^{113}Cd(γ,γ')	O	^{114}Cd(pol d,t)

E(level)[‡]	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	1/2$^+$	8.04×10^{15} y *5*	ABCDEFGHIJKLMNO	%β^-=100 μ=−0.6223009 *9* (1989Ra17) μ: optical pumping, NMR. J$^\pi$: NMR and optical spectroscopy (1976Fu06), L(d,p)=0. T$_{1/2}$: From 2007Be61 Measured in CdWO$_4$ crystal at Gran Sasso National Lab of INFN. Measured half-life of ^{113}Cd using the low-background CdWO$_4$ crystal scintillator of mass 434g. Others: 7.7×10^{15} y *3* (1996Da11) using scintillation crystals of CDW04. 9.3×10^{15} y *19* (1970Gr20) from activity measurements on enriched and natural cadmium samples. Others: 1962Wa15, 1994Al49.
263.54[#] *3*	11/2$^-$	14.1 y *5*	A C E KLMNO	%IT=0.14; %β^-=99.86 (1969De25) Q=−0.71 *7* μ: \$$\mu$=−1.0877842 *17* (1989Ra17) NMR. Q: optical double res, recalculated (1989Ra17). J$^\pi$: optical double res (1976Fu06), 264γ is E5. T$_{1/2}$: unweighted av of 13.6 y *2* (1965Fl02) and 14.6 y *5* (1972Wa11), β(t) for about one half-life.
298.597 *10*	3/2$^+$	29 ps *9*	AB E GHI K NO	μ=−0.39 *80* (1988Be45,1989Ra17) T$_{1/2}$: from B(E2) in Coul. ex. J$^\pi$: M1+E2 γ to 1/2$^+$, L(pol d,p)=2.
316.206 *15*	5/2$^+$	10.8 ns *3*	AB EF HI K NO	J$^\pi$: L(d,p)(316)=2, L(d,p)(458)=4, and M1+E2 γ from 459 to 316 gives Jπ(316)=5/2$^+$ and Jπ(458)=7/2$^+$. T$_{1/2}$: weighted av of 10.7 ns *4* (1980Oh01), 11.0 ns *6* (1972RaZM). Other: 4.9 ns *7* from B(E2) in Coul. ex.
458.633 *17*	7/2$^+$		B E I K NO	J$^\pi$: see 316 level, L(pol d,p)=4.
522.259 *24*	7/2$^-$	0.322 ns *12*	A I K NO	J$^\pi$: E2 γ to 11/2$^-$ and E1 γ to 5/2$^+$, L(pol d,p)=3. T$_{1/2}$: from $\gamma\gamma$(t) (1980Oh01).
530 *10*	7/2$^+$,9/2$^+$		E	J$^\pi$: from L(d,p)=4.
583.962 *24*	5/2$^+$	6.9 ps *14*	AB E HI K NO	μ=+0.15 *12* (1988Be45,1989Ra17) J$^\pi$: $\gamma(\theta)$ in Coul. ex. for E2 γ to 1/2$^+$, L(pol d,p)=2. T$_{1/2}$: from B(E2) in Coul. ex.
626.6 *12*	(3/2$^+$)		N	J$^\pi$: L(pol d,p)=2.
638.19 *3*	9/2$^-$		A F I K N	J$^\pi$: M1+E2 γ to 11/2$^-$. γ to 5/2$^+$, L(pol d,p)=5.

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Adopted Levels

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Y. Akovali	NDS 94,131 (2001)	1-Aug-2001

Q(β^-)=39 *12*; S(n)=5832 *10*; S(p)=7.4×10^3 *SY*; Q(α)=5169 *18* 2012Wa38
Note: Current evaluation has used the following Q record.
Q(β^-)=37 *11*; S(n)=5832 *10*; S(p)=7409 *SY*; Q(α)=5169 *19* 1995Au04

Theoretical studies:
For theoretical calculations of spontaneous fission half-life of ^{250}Cm, see, for example, 1974Ho05, 1976Ra02, 1978Po09, 1983Bo15, 1987Mo16, 1989St20 (included pairing vibrations).
Decay by pion emission probability relative to SF decay was calculated by 1988Io04.
For fission barrier calculations, see 1972Ma11, 1973Ba19, 1976Iw02, 1977Pr10, 1980Ku14, 1984Ku05, 1991Pe03.
For equilibrium deformations calculations, see 1982Du16, 1983Bo15.
Spontaneously fissioning isomeric state was predicted, and its properties were calculated by 1978Po01, 1992Bh03.
For the calculated β(E2; 0$^+$ to 2$^+$) value for the excitation of the first excited state by using the N(p)N(n) scheme, see 1993Sa05.

^{250}Cm Levels

Cross Reference (XREF) Flags

A ^{254}Cf α decay

E(level)†	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	0$^+$‡	≈8.3×10^3 y	A	%SF≈74; %α≈18; %β^-≈8 only SF decay has been observed. Spontaneous fission half-life was measured: T$_{1/2}$(SF)=17.4×10^3 y *24* (1966Rg01); 11.3×10^3 y *5* (1967Me16). Other measurement: 20×10^3 y (1957Hu76). T$_{1/2}$(SF)=11.3×10^3 y *5* is recommended by 1989Ho24 and 2000Ho27. any probable α and β^- decay branchings May be deduced from estimated partial half-lives (see below): if T$_{1/2}$(α)=45.5×10^3 y *7* and T$_{1/2}$(β^-)≈106×10^3 y, then, by using T$_{1/2}$(SF)=11.3×10^3 y, the total half-life and decay branchings are calculated as T$_{1/2}$≈8.3×10^3, and %SF≈74, %α≈18, %β^-≈8. from absence of ^{250}Cf in debris of a thermonuclear explosion test, 1956Fi11 deduced that either ^{250}Cm is stable against β decay or its β half-life is >130 y. because of the available Q(β^-)(^{250}Cm)=37 *11*, any β transition from ^{250}Cm should populate only the 2$^-$ g.s. of ^{250}Bk. Requirement of log $f^{1u}t$≥8.5 yields T$_{1/2}$(β^-)≥6.7×10^3 y. If log $f^{1u}t$≈9.7, as it is for the ^{250}Bk β^- decay to ^{250}Cf g.s., then T$_{1/2}$(β^-)≈106×10^3 y. from r$_0$ systematics (see 1998Ak04), r$_0$=1.515 *5* is estimated; by using this r$_0$ parameter, Q(α)(^{250}Cm)=5269 *19* (from 1995Au04), Iα(unobserved 5086α; g.s. to g.s.)=85 *15* per 100 α decays [from systematics Iα(to g.s.)/Iα(to 2$^+$) for the region], and by requiring that Hf(5086α)=1.0, the partial α decay half-life of ^{250}Cm is calculated as T$_{1/2}$(α)=45.5×10^3 y *7*. for a systematic study of spontaneous fissioning nuclei, see, for example, 1997Ro12. the kinetic energy distribution of fission fragments were measured by 1973Ho02.
43 *5*	2$^+$‡		A	J$^\pi$: hindrance factor (2.9) for the 5791α from ^{254}Cf; energy systematics of 2$^+$ levels in nearby even-A californium isotopes.

† Levels were populated in ^{254}Cf α decay.
‡ K=0 g.s. rotational band.

Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 108,2173 (2007)	1-Oct-2006

$Q(\beta^-)$=1175.63 *18*; S(n)=8278.2 *19*; S(p)=7405.6 *4*; $Q(\alpha)$=−3084 *5* 2012Wa38
Note: Current evaluation has used the following Q record.
$Q(\beta^-)$=1175.63 *17*; S(n)=8278.2 *19*; S(p)=7409 *7*; $Q(\alpha)$=−3084 *5* 2003Au03
Theory: 2000Yo08, 1998Su03, 1993Ch31.
Isotope Shifts: 2000Ga58, high-resolution resonant laser spectroscopy.
γ-ray source properties: 2000He14.
References where ^{137}Cs is used as the standard source, such as, for various calibrations, ETC., and not in study of ^{137}Cs structure, have not been included.

^{137}Cs Levels

Cross Reference (XREF) Flags

A	^{137}Xe β^- decay	E	^{138}Ba(d,^{3}He)
B	^{136}Xe(p,p),(p,p′) IAR	F	^{232}Th(^{136}Xe,X)
C	^{136}Xe(^{3}He,d)	G	^{136}Xe(^{232}Th,^{231}Acγ)
D	^{138}Ba(μ^-,nγ)	H	^{252}Cf SF decay

E(level)†	J^π‡	$T_{1/2}$	XREF	Comments
0.0@	7/2+	30.08 y *9*	A CDEFGH	%β^-=100 μ=+2.8413 *1* (1989Ra17); Q=+0.051 *1* (1989Ra17) $T_{1/2}$: Deduced by evaluators using the Limitation of Relative Statistical Weights (LRSW) method for analyzing the following set of discrepant (χ^2/ν=18.6) experimental values: 10970 d *20* (2004Sc04); 11018 d *10* (2002Un02); 10941 d *7* (1992Go24); 10968 d *5* (1990Ma15); 11009 d *11* (1980Ho17); 10906 d *33* (1978Gr08); 11034 d *29* (1973Co39); 11021 d *5* (1973Di01); 11023 d *37* (1972Em01); 10921 d *17* (1970Wa19); 11191 d *157* (1970Ha32); 11286 d *256*, 10921 d *183* (1965Fl01); 11220 d *47* (1965Le25); 10665 d *110* (1963Ri02); 10840 d *18* (1963Go03); 10994 d *256* (1962Fl09); 11103 d *146* (1961Fa03); 10957 d *146* (1955Br06); and 9715 d *146* (1955Wi21). [1 y = 365.2422 d]. Other evaluated results: 30.09 y *11* (2004Wo02); 30.08 y *3* (1996ChZY, 1994Ka08); 30.11 y *3* (1992Ra08); and 30.18 y *15* (1991BaZS). J^π: from LASER spectroscopy (1978Sc27, see also 1976Fu06); L=4 in (^{3}He,d) and (d,^{3}He). μ: 1989Ra17 value based on +2.8413 *4* (1957St11). Others: +2.838 *7* (1978Sc27), +2.84 *1* (1981Th06). Q: 1989Ra17 value from 1975Ac01. Others: +0.053 *4* (1972Ry03), +0.06 *2* (1978Sc27), +0.03 *4* (1981Th06).
455.491 *3*	5/2+	≤0.1 ns	A CDE	J^π: L=2 in (^{3}He,d) and (d,^{3}He); log *ft*=6.8, log $f^{1u}t$<8.5 from 7/2− parent. $T_{1/2}$: from 1975Mo06 in ^{137}Xe β^- decay.
848.88 *4*			A D	
1184.69@ *4*	(11/2+)		A FGH	
1273.20 *6*			A	
1490 *12*	1/2+		C	J^π: L=0 in (^{3}He,d).
1564.11 *6*			A	
1569.83 *4*			A	
1574.83 *6*			A	
1651.23 *6*			A	
1671.69@ *11*	(15/2+)		FGH	
1783.46 *5*			A	

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	S. K. Basu, A. A. Sonzogni	NDS 114, 435 (2013)	1-Apr-2013

Q(β^-)=972 *4*; S(n)=6423 *7*; S(p)=4946 *6*; Q(α)=2237 *7* 2012Wa38
S(2n)=14635 *12*, S(2p)=12505 *8* (2012Wa38).
α: Additional information 1.
α: Additional information 2.

^{150}Eu Levels

Cross Reference (XREF) Flags

A	^{150}Sm(p,nγ)	D	^{148}Nd(^{7}Li,5nγ)
B	^{152}Sm(p,3nγ)	E	^{152}Eu(p,t)
C	^{136}Xe(^{19}F,5nγ)		

E(level)	J$^{\pi}$‡	$T_{1/2}$	XREF	Comments
0.0	5⁻	36.9 y *9*	ABC	%ε+%β⁺=100 Q=+1.13 *5*; μ=+2.708 *11* (1989Ra17) J$^{\pi}$: J(42)=0 (atomic beam) and J(g.s.)-J(42)=5 from ^{150}Sm(p,nγ) in-beam γ-decay (1983SoZV) via the 195.3 and 183.4 γ's (if stretched dipole and quadrupole) and the 151.7 and 269.1 (if stretched dipoles). The first two γ's establish J of level 421 equal to 3 and the latter two γ's establish J(g.s.)=5. π=- from shell model and systematics of neighboring odd-A nuclei. $T_{1/2}$: from counting over 0.49×$T_{1/21/2}$, scin (1993Th04). Others: 34.2 y *12* (1975Ne05) scin counting over 0.17×$T_{1/21/2}$, 36.1 y *11* (1975Ne05) mass spect.
41.7 *10*	0⁻	12.8 h *1*	A	%β⁻=89 2 (1965Gu03); %ε+%β⁺=11 2; %IT≤5×10⁻⁸ %IT: From the assumption that B(M5)(W.u.) < 1, one gets %IT < 3×10⁻⁸, for α(M5)=1.4×10⁷ (1978Ba45). J$^{\pi}$: from atomic beam (1972Ek05). ε decay to 2⁺ suggests π=- as do shell-model arguments and systematics of neighboring odd-A nuclei. $T_{1/2}$: from 1963Yo07.
42.7 *10*	(1⁻)		A	
69.5 *8*	(2⁻)		A	
118.6 *10*	(2⁻)		A	
181.1 *8*	(3⁻)		A	
190.37 *4*	6⁻		ABC	J$^{\pi}$: M1 γ to 5⁻.
195.2 *8*	(3⁻)		A	
237.4 *10*	(1⁻)		A	
247.89 *5*	6⁻		ABC	J$^{\pi}$: M1 γ to 5⁻.
269.0 *5*	(4⁻)		A	
321.2 *6*	(4⁻)		A	
343.1 *9*	(3,2)		A	
360.14 *10*	(5⁻)		ABC	
406.4 *10*			A	
412.53 *6*	5⁻		ABC	
417.25 *5*	7⁻		ABC	
420.6 *8*	(3⁻)		A	
427.7 *7*			A	
457.7 *9*			A	
465.4 *13*			A	
488.1? *7*			A	
496.3 *12*			A	
511.0 *10*			A	
532.3 *11*			A	

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 114, 1849 (2013)	31-Dec-2012

Q(β^-)=237 *3*; S(n)=8820 *4*; S(p)=13176 *4*; Q(α)=−8556 *4* 2012Wa38

Additional information 1.

Others:

Nuclear structure.

2012Lo04, 2012Mu09, 2011Ba39, 2011Ut01, 2009Su20, 2007Al45, 2007Mo15, 2005Al47, 2005Ch12, 2005Pu04, 2004Ag02, 2004Mi54, 2004Pa04, 2002Ca48, 1985Bl11.

Nuclear reactions: 2011Su04, 2006Sc16, 2003Kn01.

Effect of strong magnetic field on ^{60}Co ε decay: 2007Li49.

Compilations.

B(E2) values: 2012Go17, 2012Pr08, 2011PrZZ.

Half-lives: 2011Ch65.

Discovery of element iron: 2007Li49.

Arguments for Jπ assignments

E(level)	L(t,p)#	γ(θ) in (t,pγ)	γ(θ) in (^{48}Ca,2nγ)	L(α,^{2}He)#	(^{64}Ni,Xγ)	Adopt
0	0				0^+	0^+
824	2	2			2^+	2^+
1974	0					0^+
2115	4	2,4			4^+	4^+
2300	2	2			2^+	a
2356	0					0^+
2673	2	1,2,3				2^+
2756	2					2^+
2793					4^+	4^+
3039	2	1,2,3				2^+
3072	4	2,4		4		4^+
3293	3					3^-
3308		1,2,3,4				
3499	4					(4^+)
3516				4,5	(5^+)	(5^+)
3520			(6^+)		(6^+)	(6^+)
3520			(4^+)		(4^+)	(4^+)
3562	(3)					(3^-)
3582			(6^+)			(6^+)
3635	2					2^+
3698	0					0^+
3867	3					3^-
3904			(6^+)			(6^+)
3929	2					2^+
3932			6^+			6^+
3958			$6^{(-)}$			$6^{(-)}$
3959			(7^+)		(7^+)	(7^+)
4053	3					3^-
4176	2					2^+
4280	3					3^-
4296			$7^{(-)}$			$7^{(-)}$
4358			$7^{(-)}$	7		$7^{(-)}$
4359	5					5^-
4440	3					3^-
4451			6^+			6^+
4503	4					4^+
4650	2					2^+
4755	(3)					(3^-)

4958	4			4^+
5006		$8^{(-)}$		$8^{(-)}$
5029	4			4^+
5103	2			2^+
5218	3			3^-
5310	(5)		5,7	(5^-)
5333		$8^{(+)}$		$8^{(+)}$
5529		$9^{(-)}$		$9^{(-)}$
5550		8^+		8^+
5620	(7)		7,5	(7^-)
5755		9^-		9^-
6475		10^+		10^+
6550		$10^{(-)}$		$10^{(-)}$
6620	(8,6)		8+6	$(8^+,6^+)$
6740		(9,10)		(9,10)
7250		$11^{(-)}$		$11^{(-)}$
7632		$11^{(-)}$		$11^{(-)}$
7890		11		11
8059		12^+		12^+
8536		$12^{(-)}$		$12^{(-)}$
9503		(13^-)		(13^-)
9996		14^+		14^+
10721		(14^-)		(14^-)
11810		15		15
12116		(15^-)		(15^-)
12319		(16^+)		(16^+)
12833		(16^-)		(16^-)
14583		(17^-)		(17^-)
14985		(18^+)		(18^+)
17956		(20^+)		(20^+)

Jπ of ^{58}Fe(g.s.) is 0^+.
a Jπ=2^+ not consistent with log*ft* in β- decay.

^{60}Fe Levels

Cross Reference (XREF) Flags

A	^{60}Mn β^- decay (1.77 s)	E	$^{58}Fe(t,p\gamma)$	I	$^{64}Ni(^3He,^7Be)$
B	^{60}Mn β^- decay (0.28 s)	F	$^{64}Ni(d,^6Li)$	J	$^{62}Ni(^{14}C,^{16}O)$
C	$^{14}C(^{48}Ca,2n\gamma)$	G	$^{48}Ca(^{15}N,2np\gamma),(^{18}O,2n\alpha\gamma)$	K	$^{208}Pb(^{64}Ni,X\gamma)$
D	$^{58}Fe(t,p)$	H	$^{58}Fe(\alpha,^2He)$	L	$^{64}Ni(^{238}U,X)$

E(level)†	Jπ‡	$T_{1/2}$#	XREF	Comments
0.0[a]	0^+	2.62×10^6 y *4*	ABCDEFGHIJKL	%β^-=100 $T_{1/2}$: From 2009Ru08. Specific activity measurement. Measured activity of ^{60}Fe in the source, its isotopic composition, and the number of iron atoms in the source. $T_{1/2}$: Other values: 1.49×10^6 y *27*, specific activity measurement and radioisotope concentration (1984Ku28). 3×10^5 y (1957Ro54). $T_{1/2}$: a larger sample material and a more accurate determination of the number of atoms suggests the result in 2009Ru08 is the most accurate. $T_{1/2}$: The half-life of ^{60}Fe plays a prominent role in various astrophysical matters.
823.83[a] *9*	2^+	7.9 ps *8*	ABCDEFG IJKL	$T_{1/2}$: From 2010Lj01 in $^{64}Ni(^{238}U,X)$. Other value: 8.0 ps *15* (1977Wa10).
1974.0 *5*	0^+		B DE	
2114.60[a] *12*	4^+	0.83 ps *21*	A CDEFG I K	

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 117, 1 (2014)	1-Oct-2013

Q(β^-)=−5738 *13*; S(n)=8984.1 *12*; S(p)=6013.9 *24*; Q(α)=3271.21 *3* 2012Wa38
Additional information 1.
Other reactions: 1991Fl03: spin dependence of GDR in Gd isotopes.
There are problems in reconciling log *ft* values from ^{148}Tb ε decay (2.20 min) with ΔJ^π of the transitions. More data are needed to clarify these problems.

^{148}Gd Levels

Cross Reference (XREF) Flags

A	^{148}Tb ε decay (60 min)	D	^{148}Gd(p,p′)
B	^{148}Tb ε decay (2.20 min)	E	(HI,xnγ)
C	^{152}Dy α decay	F	(HI,xnγ):SD

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[#]	XREF	Comments
0.0[@]	0$^+$	71.1 y *12*	ABCDE	%α=100 $T_{1/2}$: weighted average of values (in y): 74.6 *30* (1981Pr06), and 70.9 *10* (2003Fu10, preliminary result after two year measurement). Others: 97.5 y *65* (1966Fr11), 84 y *9* (1962Si14), see also 1953Ra02.
784.433[@] *15*	2$^+$	4.2 ps *12*	AB DE	J$^\pi$: L(p,p′)=2.
1273.492[&] *18*	3$^-$	34.7 ps *21*	AB DE	J$^\pi$: L(p,p′)=3.
1416.378[@] *20*	4$^+$	8.1 ps *24*	AB DE	J$^\pi$: L(p,p′)=4.
1810.98[@] *7*	6$^+$	178 ps *20*	B DE	J$^\pi$: L(p,p′)=6. log *ft*=6.3 from (9)$^+$ to this level is very low.
1834.59 *5*	2$^+$,3$^+$		A	J$^\pi$: from $\gamma(\theta)$ of oriented nuclei in ε decay (60 min).
1863.445 *24*	2$^+$		A D	J$^\pi$: L(p,p′)=2.
1912.97[&] *6*	4$^-$		AB E	J$^\pi$: γ to 3$^-$ is M1, no γ to 2$^+$.
2082.11[&] *6*	5$^-$	2.6 ps *13*	AB DE	J$^\pi$: L(p,p′)=5.
2188.67 *4*	2$^+$		A D	J$^\pi$: L(p,p′)=2.
2233.60 *4*	3$^-$		A D	J$^\pi$: L(p,p′)=3.
2310.97 *5*	2$^+$		A D	J$^\pi$: L(p,p′)=2.
2424.10 *9*	3$^+$,4$^+$		A	J$^\pi$: from $\gamma(\theta)$ of oriented nuclei in ε decay (60 min); π from M1+E2 γ to 4$^+$, 1416.
2503.70 *6*	(1,2,3)$^-$		A	J$^\pi$: γ to 3$^-$ is E2,M1 and γ to 2$^+$.
2505.80 *4*	3$^-$		A D	J$^\pi$: γ to 4$^+$ is E1; γ to 2$^+$; seen in (p,p′).
2522.04 *11*	4$^+$		A D	J$^\pi$: L(p,p′)=4.
2563.81[&] *9*	7$^-$	21.3 ps *30*	B E	J$^\pi$: γ to 5$^-$ ΔJ=2, E2; γ to 6$^+$ is E1.
2566.82[&] *18*	6$^-$		E	
2614.59 *5*	2$^+$		A D	J$^\pi$: L(p,p′)=2.
2632.65[a] *8*	5$^-$		A DE	J$^\pi$: L(p,p′)=5.
2693.35[@] *10*	8$^+$	13.2 ps *28*	B DE	J$^\pi$: γ to 6$^+$ is ΔJ=2, E2; no γ to J<6.
2694.67[&] *13*	9$^-$	16.6 ns *3*	B E	μ=−0.162 *18* (2005St24,1987Da27) Q=1.01 *5* (2005St24,1982Ha22) J$^\pi$: γ to 7$^-$ is E2, γ to 6$^+$ is E3 (from $\gamma(\theta)$ and RUL). $T_{1/2}$: weighted average of 17.5 ns *10* (1990Pi17), 17.5 ns *10* (1984Lu09), 16.5 *3* (1979Ha15), 17.3 ns *20* (1973Kr10), 16.3 ns *9* (1972HaXQ), and 16.7 ns *9* (1971HaXD). μ: Other: −0.252 *81* (1979Ha15); both 1987Da27 and 1979Ha15 used the time

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Huang Xiaolong and Kang Mengxiao	NDS 121, 395 (2014)	1-Mar-2014

$Q(\beta^-)$=−2845 *26*; S(n)=6887 *23*; S(p)=6075 *23*; $Q(\alpha)$=2277 *24* 2012Wa38

^{195}Hg Levels

Cross Reference (XREF) Flags

A	^{195}Hg IT decay (41.6 h)	D	(HI,xnγ)
B	^{195}Tl ε decay	E	(HI,xnγ):SD
C	^{196}Hg(p,d)		

E(level)†	Jπ‡	$T_{1/2}$	XREF	Comments
0.0	1/2⁻	10.53 h *3*	ABC	%ε+%β⁺=100 μ=+0.5414749 *14* (1973Re04,2011StZZ) Jπ: optical double resonance and μ analysis (1978LeZA,1976Fu06). $T_{1/2}$: From 2001Li17 (weighted average of six γ(t) measurements). Others: 9.5 h *5* (1952Hu54), 11.5 h *10* (1973Vi09). μ: From optical pumping, nuclear magnetic resonance (1973Re04); ^{199}Hg standard. Others: +0.541475 *1* (1978LeZA), +0.542272 *34* (1978LeZA, calculated with the use of hyperfine-structure ratio relative to ^{199}Hg), +0.538 (1976Fu06). For the μ calculation see 1985Kr14.
37.083 *19*	3/2⁻	<50 ps	ABC	Jπ: γ to 1/2⁻ is M1+E2. $T_{1/2}$: from γγ(t) measurement in ^{195}Hg IT decay (1973Vi09).
53.289 *20*	5/2⁻	0.72 ns *3*	ABC	Jπ: γ to 1/2⁻ is E2 and γ from 13/2⁺ is M4. $T_{1/2}$: from γγ(t) measurement in ^{195}Hg IT decay (1969Ba42). Other: 0.79 ns *7* (1961Re12).
176.07& *4*	13/2⁺	41.6 h *8*	ABCD	%IT=54.2 *20*; %ε+%β⁺=45.8 *20* μ=−1.0446473 *26* (1973Re04,2011StZZ) Q=+1.08 *11* (1986Ul02,2011StZZ) μ: From optical pumping, nuclear magnetic resonance (1973Re04), ^{199}Hg standard. Others: −1.044647 *3* (1978LeZA), −1.05565 *13* (1978LeZA, calculated with the hyperfine-structure ratio relative to ^{199}Hg standard), -1.038 (1976Fu06). Q: ^{201}Hg standard. Other: +1.27 *11* (1978LeZA), +1.2 (1976Fu06). For the Q calculation see 1985Kr14. Jπ: optical double resonance and μ analysis (1978LeZA,1976Fu06). $T_{1/2}$: from γ(t) measurement (1973Vi09). Others: 43 h *5* (1961Ju06), 42 h *3* (1954Br56), 40.0 h *5* (1953Hu44), and 38.0 h (1951Mo55). For the suggested configuration, see 1986AgZZ.
279.203 *24*	3/2⁻		BC	Jπ: γ to 1/2⁻ is M1+E2.
300.55 *3*	3/2⁻,5/2⁻		BC	Jπ: γ to 1/2⁻ is E2.
373.17 *11*	(9/2⁺)		B	Jπ: 373-, 844-, 847- and 1304-keV levels are low-spin members of the i13/2⁺ band; (3/2⁺) to 5/2⁺ to 9/2⁺ to 13/2⁺ and (3/2⁺) to 7/2⁺ to 9/2⁺ to 13/2⁺ are γ-ray cascades of the 456-471-197 and 426-501-197 keV; the energies of the transitions in these levels are close to the analogous cascades in ^{197}Hg (1977Ke18,1977ZgZZ); E2 of the 197 and 471-keV γ's are consistent (1978Go15).
410.31 *4*	3/2⁻,5/2⁻,7/2⁻		B	Jπ: γ to 5/2⁻ is M1.
422.51 *10*	(1/2⁻ to 7/2⁻)		B	Jπ: (E2) 407γ to this level from 3/2⁻.
547.06& *11*	17/2⁺		D	Jπ: γ to 13/2⁺ is stretched E2 and decoupled i13/2⁺ band member.
595.48 *4*	(3/2)⁻		B	Jπ: γ to 3/2⁻ is M1 and log *ft*=7.29 from 1/2⁺; (M1+E2) γ to 5/2⁻ rules out 1/2⁻.

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 109, 2257 (2008)	15-Aug-2008

Q(β^-)=−2238 *5*; S(n)=7872.8 *15*; S(p)=9094.8 *18*; Q(α)=−5520.2 *14* 2012Wa38
Note: Current evaluation has used the following Q record.
Q(β^-)=−2239 *6*; S(n)=7872.9 *23*; S(p)=9093.5 *23*; Q(α)=−5519.4 *23* 2003Au03
For isotope shift data, see 1995Ke04.

^{81}Kr Levels

Cross Reference (XREF) Flags

A	^{80}Se(α,3nγ)	E	^{81}Rb ε decay (30.5 min)	I	^{81}Kr IT decay
B	^{78}Se(α,nγ)	F	^{80}Kr(d,p), (pol d,p)	J	^{81}Br(p,n)
C	^{81}Br(p,nγ)	G	^{73}Ge(^{11}B,p2nγ), ^{74}Ge(^{10}B,p2nγ)		
D	^{81}Rb ε decay (4.572 h)	H	^{81}Br(^{3}He,t), (^{3}He,tγ)		

E(level)†	J$^\pi$	$T_{1/2}$‡	XREF	Comments
0.0@	7/2+	2.29×10^5 y *11*	ABCDE GHI	%ε=100 μ=−0.908 *2*; Q=+0.644 *4* μ: from collinear LASER fast-beam spectroscopy (1995Ke04); relative to ^{83}Kr standard, diamagnetic correction included. Other: −0.909 *4* (1993Ca41; LASER resonance fluorescence spectroscopy, ^{83}Kr standard). Q: +0.629 *13* (1993Ca41; LASER resonance fluorescence spectroscopy, if Q(^{83}Kr)=0.253 *5* (1989Ra17)), adjusted by 2001Ke15 to +0.644 *4* assuming their value of 0.259 *1* for Q(^{83}Kr). Other: +0.64 *7* (1995Ke04, collinear LASER fast-beam spectroscopy); uncertainty includes uncertainty in electric-field gradient and the Sternheimer correction. $\Delta\langle r^2\rangle$(^{86}Kr,^{81}Kr)=+0.099 (1995Ke04); uncertainty is 0.004 (statistical only), 0.018 (including systematic uncertainties), 0.034 (total uncertainty). $\Delta\langle r^2\rangle$(^{80}Kr,^{81}Kr)=−0.015 *8* (1996Li25; statistical uncertainty only). J$^\pi$: E3 γ from 1/2−; log $f^{1u}t$=11.0 for ε decay to 3/2−. $T_{1/2}$: 2.13×10^5 y *+16−26* from 1964Ea05, adjusted by evaluator assuming ω_K(Br)=0.618 *19* and (adopted) εK=0.8473; other: 2.1×10^5 y *5* (1950Re54).
49.57@ *3*	9/2+	3.9 ns *4*	ABCDEFGH	J$^\pi$: (pol d,p); L(d,p)=4. $T_{1/2}$: from centroid shift of time curve in (α,nγ). Other: 8.4 ns *10* (1979To08)from n-γ(t) in (p,nγ); 1984Do02 suggest that discrepancy May result from the use of Compton-scattered photons by 1979To08 instead of the photopeak when determining their 50γ prompt time distribution.
190.64& *4*	1/2−	13.10 s *3*	ABCDEF HIJ	%IT=99.9975 *4*; %ε=2.5×10^{-3} *4* μ=+0.586 *2* %ε from ^{81}Kr ε decay (13.10 s). μ: From collinear LASER fast-beam spectroscopy (1995Ke04); relative to ^{83}Kr standard, diamagnetic correction included. $\Delta\langle r^2\rangle$(^{86}Kr,^{81}Kr)=+0.080 (1995Ke04); uncertainty is 0.008 (statistical only), 0.022 (including systematic uncertainties), 0.041 (total uncertainty). $\Delta\langle r^2\rangle$(^{80}Kr,^{81}Kr)=−0.034 *11* (1996Li25; statistical uncertainty only). $\langle r^2\rangle^{1/2}$(CHARGE)=4.1953 *21* (2004An14). J$^\pi$: from (pol d,p); L(d,p)=1. $T_{1/2}$: weighted average of 13.10 s *2* from 1987Lo06 and 13.32 s *15* from 1987Da06. Others: 13 s *2* (1940Cr06), 13 s *1* (1969Ha03), 12.8 s *3* (1986Al11), 13.4 s *7* (2005Ka39).

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	F. G. Kondev	NDS 101, 521 (2004)	1-Feb-2004

$Q(\beta^-)$=−2706 *6*; S(n)=6731.66 *11*; S(p)=6713.07 *21*; $Q(\alpha)$=1468.1 *12* 2012Wa38
Note: Current evaluation has used the following Q record.
$Q(\beta^-)$=−2708 *7*; S(n)=6731.67 *11*; S(p)=6713.09 *21*; $Q(\alpha)$=1468.3 *12* 2003Au03

^{205}Pb Levels

Cross Reference (XREF) Flags

A	^{205}Pb IT decay (5.55 ms)	G	^{204}Pb(n,γ) E=1.95 keV	M	^{206}Pb(^{3}He,α)
B	^{205}Bi ε decay	H	^{204}Pb(d,p)	N	^{207}Pb(p,t)
C	^{209}Po α decay	I	^{204}Pb(d,pγ)	O	^{209}Bi(π$^-$,4nγ)
D	^{204}Hg(α,3nγ)	J	^{205}Pb(d,d′)	P	^{206}Pb(γ,n)
E	^{204}Hg(^{9}Be,xnγ)	K	^{206}Pb(p,d)	Q	^{206}Pb(n,2nγ)
F	^{204}Pb(n,γ) E=thermal	L	^{206}Pb(d,t)		

E(level)[†]	Jπ[‡]	$T_{1/2}$	XREF	Comments
0.0[d]	5/2⁻	1.73×10^7 y *7*	ABCDEFGHIJKLMNOPQ	%ε=100 Jπ: L=3 in ^{204}Pb(d,p) and ^{206}Pb(p,d), μ. $T_{1/2}$: Using $T_{1/2}$(εL)=2.89×10^7 y *3*, deduced from the 1958Wi40 data and ω(L)=0.379 *15* (1996Sc04), and theoretical εL/(ε+β$^+$)=0.5989 *14*, deduced using Q+=50.5 keV *5* (2003Au03). μ=+0.7117 *4* (1986An06,1989Ra17), using the laser induced fluorescence spectroscopy in thermal atomic beam technique. Others: 0.6946 *8* (1982Th05) and 0.704 *5* (1987Ba85). Q=+0.226 *37* (1986An06,1989Ra17), using the laser induced fluorescence spectroscopy in thermal atomic beam technique. Others: 0.2 *4* (1987Ba85). Δ<r^2>(^{208}Pb,^{205}Pb)=−0.2032 *35* (1982Th05) and -0.1967 *16* (1986An06).
2.329[e] *7*	1/2⁻	24.2 μs *4*	BC FGHI KL O	Jπ: L=1 in ^{206}Pb(p,d) and ^{204}Pb(d,p); 2.328γ E2 to 5/2⁻. $T_{1/2}$: From ^{209}Po α decay (1994Kr11).
262.833[f] *25*	3/2⁻		BC FGHIJKLMN P	Jπ: 260.50γ M1(+E2) to 1/2⁻; 262.8γ M1(+E2) to 5/2⁻; L=1 in ^{206}Pb(p,d) and ^{204}Pb(d,p).
576.19[f] *3*	3/2⁻		BC FGHIJKL N PQ	XREF: C(586)N(580)P(580). Jπ: 313.43γ M1(+E2) to 3/2⁻; 573.85γ M1+E2 to 1/2⁻; 576.3γ to 5/2⁻; L=1 in ^{206}Pb(p,d) and ^{204}Pb(d,p).
703.427[g] *21*	7/2⁻		AB DE HIJK NO Q	Jπ: 127.24γ to 3/2⁻; 703.44γ M1+E2 to 5/2⁻; 310.3γ E3 from 13/2⁺ L=2 in ^{205}Pb(d,d′).
761.43[d] *4*	5/2⁻		BC F HIJKL NO	XREF: C(790)L(750). Jπ: 185.22γ M1(+E2) to 3/2⁻; 498.40γ (M1) to 3/2⁻; 759.10γ E2 to 1/2⁻; L=3 in ^{204}Pb(d,p) and ^{206}Pb(p,d).
803.38[f] *6*	(1/2,3/2)⁻		FGHIJKL N	Jπ: 803.34γ to 5/2⁻, 540.6γ and 226.9γ to 3/2⁻; L=1 in ^{204}Pb(d,p).
987.63[g] *3*	9/2⁻		AB DE HIJKL NO Q	XREF: L(980)N(993). Jπ: 284.15γ M1(+E2) to 7/2⁻; 987.66γ E2 to 5/2⁻; L=(4) in ^{207}Pb(p,t).
996.48[e] *18*	(1/2,3/2)⁻		F H K	XREF: H(999). Jπ: L=1 in ^{204}Pb(d,p) and ^{206}Pb(p,d).

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. Chen # and F. G. Kondev	NDS 126, 373 (2015)	30-Sep-2013

Q(β^-)=−3483 *5*; S(n)=6967.7 *19*; S(p)=4784.8 *24*; Q(α)=4979.2 *14* 2012Wa38
Additional information 1.

^{209}Po Levels

Additional information 2.

Cross Reference (XREF) Flags

A	^{209}At ε decay	E	^{208}Pb(α,3nγ)
B	^{213}Rn α decay	F	^{209}Bi(p,n),(p,np′) IAS
C	^{204}Hg(^{9}Be,4nγ)	G	^{209}Bi(d,2nγ)
D	^{207}Pb(α,2nγ)	H	^{210}Po(d,t),(p,d)

E(level)	J$^\pi$†	T$_{1/2}$	XREF	Comments
0.0	1/2$^-$	124 y *3*	ABCDE GH	%α=99.546 *7*; %ε+%β^+=0.454 *7* μ=0.68 *8* (1966Ch27) J$^\pi$: optical spectroscopy (1976Fu06), L(d,t)=1. T$_{1/2}$: Weighted average of 125.2 y *33* in 2014Co16, based on 30 datasets measured over a period of 20.7 years using a liquid scintillator technique (superseded 128 y *7* by the same collaboration (2007Co07)) and 120 y *6* in 2015Po03, based on measurements of two sources measured for 359 and 369 days. Other: 102 y *5* from ^{209}Po/^{208}Po mass and activity ratios in 1956An05 and the presently adopted T$_{1/2}$(^{208}Po)=2.898 y *2*. Authors in 1956An05 obtained T$_{1/2}$=103 y using T$_{1/2}$(^{208}Po)=2.93 y *3*. %α,%ε+%β^+: from measured %I(ε)=0.454 *7* and %I(ε+β)+%I(α)=100 (1996Sc24). Others: %α=99.52 *4* (1989Ma05) and 99.74 (1966Ha29). Additional information 3. μ: from optical spectroscopy (1966Ch27). A value of≈+0.77 quoted by 1989Ra17. Other: 0.61 *5* from 1991Ko32 by atomic beam laser spectroscopy. The rms charge radius (<r^2>)$^{1/2}$: 2013Se03 gives $\delta\nu$(^{209}Po,^{196}Po)=−6.75 GHz *10*, $\delta\langle r^2\rangle$(^{209}Po, ^{210}Po)=−0.0813 fm^2 *10* and $\langle\beta_2^2\rangle^{1/2}$=0.09. The systematic uncertainties from electronic factor and mass-shift calculations not included. configuration=$\nu(3p_{1/2})^{-1}$.
544.98 *8*	5/2$^-$	70 ps *20*	AB DE GH	J$^\pi$: L(d,t)=3, 545.0γ E2 to 1/2$^-$. T$_{1/2}$: from (790.2γ)(545.0γ)(Δt) in ^{209}At ε+β^+ decay (1971Al31). configuration=$\nu(2f_{5/2})^{-1}$.
854.35 *15*	3/2$^-$		A H	J$^\pi$: L(d,t)=1, 554.6γ E2 from 7/2$^-$.
1175.34 *8*	5/2$^-$		A H	J$^\pi$: L(d,t)=3; 1175.3γ E2 to 1/2$^-$.
1213.7 *11*	1/2$^-$,3/2$^-$		A H	J$^\pi$: L(d,t)=1.
1326.85 *9*	9/2$^-$		A CDE G	J$^\pi$: 781.9γ E2 to 5/2$^-$; see also 1761-keV level. configuration=$\pi(^1H_{9/2})^{+2}\otimes\nu(p_{1/2})^{-1}$.
1408.90 *9*	7/2$^-$		A	J$^\pi$: 233.6γ M1(+E2) to 5/2$^-$, 903.0γ E1(+M2) from 9/2$^+$.

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 111,275 (2010)	1-Oct-2009

Q(β^-)=32 *5*; S(n)=6485 *9*; S(p)=5146 *5*; Q(α)=2287 *5* 2012Wa38
Note: Current evaluation has used the following Q record.
Q(β^-)=30 *4*; S(n)=6487 *9*; S(p)=5149 *4*; Q(α)=2285 *5* 2003Au03,2009AuZZ
Other reactions:
^{181}Ta(α,n), Eα=12, 13, 13.9 MeV (1998Sc36). The observed ^{184}Re yields showed large discrepancies for different irradiation times. authors interpreted this as evidence for the existence of an otherwise unknown isomer of ^{184}Re with $T_{1/2}\approx$2 h.
W(^{3}He,t), E=200 MeV (1991Ja04): natural W target; unresolved triton groups to IAS from constituent isotopes dominated by that for α=184; deduced Q(IAS)=16904 *16* and Coulomb displacement energy=17668 *16* for E=15404 *16* IAS.

^{184}Re Levels

Cross Reference (XREF) Flags

A	^{184}Re IT decay (169 d)
B	^{185}Re(d,t),(^{3}He,α)
C	^{183}W(^{3}He,d),(α,t)
D	^{180}Hf(^{7}Li,3nγ)

E(level)[†]	J^π[‡]	$T_{1/2}$[#]	XREF	Comments
0.0[a]	3$^{(-)}$	35.4 d *7*	ABCD	%ε+%β^+=100 μ=+2.53 *5* (1981Ha22) Q=+2.8 *2* μ: from 1981Ha22, NMR on oriented nuclei. Others: 2.53 *9* (1973Hu06), 2.48 *12* (1973Kr01) from static nuclear orientation. Q: from 1983Ha52, static nuclear orientation. Other: 1981Er01 +3.3 *3* (1981Er01; nuclear orientation). J^π: μ consistent with J=3 only; parity from Nilsson assignment. $T_{1/2}$: from 2006Ha51; source produced by ^{185}Re(γ,n) reaction which should not excite the 169 d isomer. Others: 1960Bo07 (38 d *1*), 1962Dz04 (38.0 d *5*), 1963Jo03 (33 d *3*), 1965Bl06 (34 d *5*); some or all of these measurements May have been perturbed by presence of the then-unknown 169 d isomer.
56[k] *3*	(1$^-$)[&]		B	
74.01[f] *16*	(2$^-$)		BCD	
104.7395[a] *14*	4$^{(-)}$		AB D	J^π: M4-M1+E2 cascade from the 188 level to the 104 level to the 3$^{(-)}$ g.s., and crossover from 188 to g.s. with mult=E3 or E4 or E5.
141.92[f] *15*	(3$^-$)		BCD	J^π: probable doublet based on rotational band predictions. No peak broadening was observed.
188.0463[i] *17*	8$^{(+)}$	169 d *8*	AB	%ε=25.5 *8*; %IT=74.5 *8* μ=(+)2.88 *10* μ: from nuclear orientation; weighted average of 2.86 *13* (1973Hu06) and 2.90 *15* (1973Kr01). $T_{1/2}$: from 1963Jo03. Others: 1965Bl06 (166 d *12*), 1964Ha06 (160 d). J^π: see comment on 104.7 level.
237.17[a] *10*	5$^{(-)}$		B D	J^π: D intraband 133γ to 4$^{(-)}$ 105; band assignment.
242.15[f] *18*	(4$^-$)		B D	J^π: 100γ to (3$^-$) 142; band assignment.
256.60[k] *20*	(3$^-$)		B D	
311.62[b] *11*	(4$^-$)	<6 ns	B D	J^π: gammas to 4$^{(-)}$ 105 and 3$^{(-)}$ g.s.; band assignment.
347.56[d] *13*	(6$^-$)	8.1 ns *8*	B D	J^π: M1 110γ to 5$^{(-)}$ 237; 243γ to 4$^{(-)}$ 105; band assignment.
368.81[f] *18*	(5$^-$)		B D	J^π: intraband D 127γ to (4$^-$) 242; band assignment.

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	D. De Frenne and A. Negret	NDS 109, 943 (2008)	1-May-2007

Q(β^-)=39.40 *22*; S(n)=8461 *6*; S(p)=1.132×10^4 *4*; Q(α)=−5177 *10* 2012Wa38
Note: Current evaluation has used the following Q record.
Q(β^-)=39.40 *21*; S(n)=8466 *7*; S(p)=11320 *60*; Q(α)=−5190 *22* 2003Au03

^{106}Ru Levels

Cross Reference (XREF) Flags

A	^{106}Tc β^- decay (35.6 s)	D	^{104}Ru(^{18}O,^{16}Oγ)
B	^{104}Ru(t,p)	E	(HI,xnγ)
C	^{104}Ru(t,pγ)	F	^{252}Cf SF decay

E(level)†	J$^\pi$‡	T$_{1/2}$	XREF	Comments
0.0#	0+	371.8 d *18*	ABCDEF	%β^-=100 T$_{1/2}$: From the evaluation of 2004Wo02. Others: 373.59 d (1980Ho17) *15*, 371.63 d *17* (1977DeYO), 371.7 d *15* (1983Wa26), 366.5 d *8* (1956Sc87), 372 d *4* (1957Me47), 365.8 d *17* (1960Ea02), 371 d 1 (1961Wy01), 368.0 d *18* (1965Fl02).
270.07# *4*	2+	0.20 ns *3*	ABCDEF	g=+0.3 *1* J$^\pi$: L=2 (t,p). T$_{1/2}$: From time-integral perturbed angular correlations with Gammasphere in connection with a ^{252}Cf SF source (2004Sm04,2005Sm08). T$_{1/2}$ calculated assuming the same transition quadrupole moment as ^{108}Ru. Other: 0.26 ns *7* (1995Sc24). g: From ^{252}Cf SF decay (2004Sm04,2005Sm08).
714.69# *10*	(4+)		AB DE	J$^\pi$: L=(4) in (t,p) and (444γ)(270γ)(θ) data consistent with 4-2-0 cascade.
792.31@ *4*	2+		AB DE	J$^\pi$: L=2 (t,p).
990.62 *5*	0+		ABC	J$^\pi$: L(t,p)=0.
1091.55@ *7*	(3+)		A DE	J$^\pi$: suggested by 1980Su01 from similar decay properties of this level compared to the 3+ levels in neighboring nuclei: ^{102}Ru, ^{104}Ru, ^{108}Ru. Consistent with (821γ)(270γ)(θ) data.
1295.8# *2*	(6+)		DE	J$^\pi$: suggested from DWBA calculations in (^{18}O,^{16}O).
1306.8@	(4+)		E	
1392.21 *7*	2+		A	J$^\pi$: deexcites to 0+ and 4+ states. (1122γ)(270γ)(θ) data consistent with 2-2-0 cascade.
1641.1@	(5+)		E	
1688.41 *21*			A	
1774.37 *8*	(2+)		AB	J$^\pi$: from L=(2) in (t,p). Consistent with J=2,3,4 suggestion from (1504γ)(270γ)(θ).
1885.61 *9*	(2+)		AB	J$^\pi$: from L=(2) in (t,p). Consistent with (1615γ)(270γ)(θ) data suggesting J=1,2,3.
1907.8@	(6+)		B E	
1973.4# *4*	(8+)		DE	XREF: E(1975). J$^\pi$: from agreement with DWBA calculations in (^{18}O,^{16}O).
2151 *8*			B	
2239.40 *7*	(1)		A	J$^\pi$: (1969γ)(270γ)(θ) suggests J=1. Consistent with predominant deexcitation to 0+,2+ states.
2284.1@	(7+)		E	
2367 *5*	(4+)		B	L(t,p)=(4).

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Zoltan Elekes and Janos Timar	NDS 129, 191 (2015)	28-Feb-2015

Q(β^-)=4363 *19*; S(n)=6002 *20*; S(p)=8448 *22*; Q(α)=−619×10^1 *4* 2012Wa38

^{128}Sb Levels

Cross Reference (XREF) Flags

A ^{128}Sn β^- decay (59.07 min)
B ^{128}Sb IT decay (10.4 min)

E(level)†	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	8$^-$	9.05 h *4*	AB	%β^-=100 μ=1.31 *19* (1989Ra17) μ: from static nuclear orientation (1972Kr15). J$^\pi$: J=8 from atomic-beam magnetic resonance (1974Ek01). ^{128}Sb g.s. μ agrees with theoretical value of 1.3 for configuration=((π1g$_{7/2}$)(ν^1H$_{11/2}$))8$^-$ (1972Kr15). T$_{1/2}$: from weighted average of 9.06 h *3* (1967Ha27), 8.9 h *2* (1962Dr01), 9.9 h *5* (1962Ha16), 8.6 h *2* (1962Uh01), 9.6 h *3* (1965Br34), 8.6 h *6* (1971Ki15), 9.03 h *9* (1972Pa13). Other: 9.6 h (1967Ha27). μ: from $\gamma(\theta)$ in polarized ^{128}Sb (1972Kr15).
0.0+x	5$^+$‡	10.41 min *18*	AB	%β^-=96.4 *10*; %IT=3.6 *10* E(level): energy difference between this level and ground state is estimated to be≤20 keV from T$_{1/2}$ systematics for E3 transitions of even Sb isotopes (1975Im01). The fact that no K x ray of ^{128}Sb is found in IT decay partially supports the above result. T$_{1/2}$: weighted average of 10.3 min *3* (1955Fr11), 10.8 min *2* (1962De11), 10.1 min *2* (1962Dr01), 9.9 min *5* (1962Ha16), 11.0 min *5* (1962Uh01), 9 min *1* (1966To02).
45.70+x *20*	4$^+$‡		A	
77.8+x *3*	3$^+$‡		A	
152.7+x *3*	(2$^+$,3$^+$)		A	J$^\pi$: γ from 1$^+$ and M1 γ to 3$^+$.
482.4+x *3*	(2,3)$^+$		A	J$^\pi$: γ from 1$^+$ and γ to 4$^+$.
635.2+x *3*	1$^+$		A	J$^\pi$: log *ft*=4.4 from 0$^+$.
751.6+x?			A	E(level): cascade order of 80.9γ and 115.9γ has not been determined in ^{128}Sn β^- decay.
833.0+x	1$^+$		A	J$^\pi$: log *ft*=4.6 from 0$^+$.

† E(levels) are adopted from ^{128}Sn β^- decay.
‡ J(0.0+x) is 5,6,7 from log *ft*=6.0 of β^- decay to 6$^+$. Three-step γ-cascade relation, 557.3γ-32.1γ(M1)–45.7γ(M1) between 635.1+x 1$^+$ and 0.0+x establishes J$^\pi$(0.0+x)=5$^+$, J$^\pi$(45.7+x)=4$^+$, and J$^\pi$(77.8+x)=3$^+$ as the most likely spin sequence.

γ(^{128}Sb)

E$_i$(level)	J$^\pi_i$	E$_\gamma$†	I$_\gamma$†	E$_f$	J$^\pi_f$	Mult.	α&	Comments
0.0+x	5$^+$	(<20.0)		0.0	8$^-$	[E3]		E$_\gamma$,Mult.: expected E3 from ΔJ$^\pi$. Energy difference between this level and g.s. was estimated to be≤20 keV from T$_{1/2}$ systematics for E3 transitions of even Sb isotopes (1975Im01).
45.70+x	4$^+$	45.7 *2*	100	0.0+x	5$^+$	M1§	5.94 *12*	α(K)=5.11 *10*; α(L)=0.665 *13*; α(M)=0.132 *3*; α(N)=0.0254 *5*; α(O)=0.00249 *5*

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 135, 193 (2016)	31-May-2016

Q(β^-)=150.6 *13*; S(n)=6962.83 *13*; S(p)=10389 *10*; Q(α)=−6485.38 *23* 2012Wa38
S(2n)=17460.57 *22*, S(2p)=19282.50 *23* (2012Wa38).
1949PaZZ: ^{79}Se separated from fission fragments and measured half-life. A 3.9-min isomer in ^{79}Se identified by 1950Fl62.
There are 20 neutron resonances from 0.38 to 40.5 keV, with excitation energies from 6963 to 7003 keV. See ^{78}Se(n,γ):resonances dataset for energies and parameters.
Recent nuclear structure theory references (levels, J, π, transition probabilities, etc.): 2015Ka46, 2013Ku23, 2008Yo07, 1993Do17, 1988Ya01.
Additional information 1.

^{79}Se Levels

Band assignments are from 1998PrZX.

Cross Reference (XREF) Flags

A	^{79}As β^- decay (9.01 min)	F	^{78}Se(n,γ) E=383 eV	K	^{80}Se(p,d)
B	^{79}Se IT decay (3.92 min)	G	^{78}Se(n,γ):resonances	L	^{80}Se(d,t)
C	^{76}Ge(α,nγ)	H	^{78}Se(pol d,p),(d,p)	M	^{80}Se(γ,n)
D	^{77}Se(t,p)	I	^{78}Se(d,pγ)		
E	^{78}Se(n,γ) E=thermal	J	^{78}Se(α,^{3}He)		

E(level)†	J$^\pi$‡	T$_{1/2}$#	XREF	Comments
0.0&	7/2$^+$	3.27×10^5 y *28*	ABC EF IJK	%β^-=100 μ=−1.018 *15* (1953Ha50,2014StZZ) Q=+0.8 2 (1953Ha50,1954Bi40,1962Ko22, 2014StZZ,2013StZZ) J$^\pi$: microwave absorption (1953Ha50). L(p,d)=4 and E3 γ from 1/2$^-$. Probable Configuration=($\|ng_{9/2}^{-3}$)$_{7/2+}$ (1953Ha50). μ,Q: from microwave absorption (1953Ha50,1954Bi40), recalculated by 1962Ko22. T$_{1/2}$: unweighted average of 2.78×10^5 y *18* (2014Do20) (AMS and liquid scintillation counting), 3.27×10^5 y *8* (2010Jo09, inductively coupled plasma optical emission spectrometry (ICP-OES) and liquid scintillation counting); 3.77×10^5 y *19* (2007Bi01, inductively coupled plasma mass spectrometry (ICP-MS) and liquid scintillation counting (LSC)). In 2014Do20, source was obtained from 57% enriched ^{78}Se irradiated with neutrons. In 2010Jo09 and 2007Bi01, source was obtained from chemical separation of ^{79}Se fission fragment from reactor fuel. 2010Jo09 accounted for contaminants present in the sample by γ counting whereas 2007Bi01 and 2014Do20 did not seem to correct for the presence of contaminants. The weighted average is 3.26×10^5 y *18*, but the reduced χ^2=7.2 as compared to the critical χ^2=3.0 at 95% confidence level. T$_{1/2}$: others: earlier values from the same research group as 2014Do20 using different methods: 9.15×10^4 y *45* (2010JiZZ, AMS spectrometry), 2.95×10^5 y *38* (2002Ji07,2001Ji04,AMS (accelerator mass spectrometry); 2.80×10^5 y *36* (2002He19, AMS and x-ray detection method), 2.9×10^5 y *5* (revised by 2001Ji04 from 1.24×10^5 y *19* in 2000He19); 11×10^5 y *2* (1997Ji07,1996Ji06); 11.3×10^5 y *17* (1997Li44,chemical method); 4.8×10^5 y *4* (1995Yu08,chemical method). Earliest measurement: ≤6.5×10^5 y (T$_{1/21/2}$≤6.5×10^4 y reported by

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Christian Ouellet, Balraj Singh	NDS 112, 2199 (2011)	24-Aug-2011

Q(β^-)=227.2 *3*; S(n)=9200.0 *3*; S(p)=16412 *21*; Q(α)=−11483.9 *21* 2012Wa38

Note: Current evaluation has used the following Q record.

S(2n)=15787.4 *3*, S(2p)=29764 *13* (2011AuZZ).

Values in 2003Au03: Q(β^-)=224.31 *19*, S(n)=9203.22 *3*, S(p)=16416 *20*, S(2n)=15790.61 *4*, S(2p)=29748 *8*.

Q(β^-)=227.2 *3*; S(n)=9200.0 *3*; S(p)=16412 *20*; Q(α)=−11483.9 *20* 2011AuZZ

Mass measurements: 2003Bl17, 2009Kw02, 2009Sc09.

Mass deduced IMME analysis: 2010Ka30.

Strong absorption radius measurement: 1999Ai02:

2001Pa52: ^{31}Si(n,γ) E=thermal, measured prompt Eγ=9201.798 keV *5* from the capture state to g.s. This gives S(n)=9203.218 keV *5*.

Nuclear structure calculations: 2011Lu16, 2009Bo16, 2009Yo05, 2007Co22, 2004Kh16, 2002St30, 2000Ro06, 1997Ut01, 1987Co31.

^{32}Si Levels

Cross Reference (XREF) Flags

A	^{32}Al β^- decay (33.0 ms)	D	Coulomb excitation
B	^{30}Si(t,p)	E	^{208}Pb(^{37}Cl,X)
C	^{30}Si(t,pγ)		

E(level)†	J$^{\pi\ddagger}$	$T_{1/2}$	XREF	Comments
0	0$^+$	153 y *19*	ABCDE	%β^-=100 r_0^2=1.15 fm^2 *7* (1999Ai02 in Si(^{32}Si,X) at 44.78 MeV/nucleon). Also cross section measured. $T_{1/2}$: Weighted average (by LWM (limitation of statistical weights method) of 132 y *13* (1993Ch10, average of 128 y *20* and 134 y *16* from two different samples); 162 y *12* (1991Th06); 133 y *9* (1990Ho27, average of 135 y *10*, 132 y *9* and 136 *13* from three different samples); 172 y *4* (1986Al10); 108 y *18* (1980El01) and 101 y *18* (1980Ku11). The LWM method increased the uncertainty of 4 y (1986Al10) to 5.6 y, so that its relative weight did not exceed 50%. Normalized χ^2=5.8. The values from indirect methods, described below, were not used in the averaging procedure because the accumulation rates (of ^{32}Si) in ice cores and sediments are not known well, and the cross sections in reactions are poorly known for determining yields that were used to estimate $T_{1/2}$ in the pre-1970 measurements. See 1991Ku26 for a review of ^{32}Si half-life measurements and 2009Se07 for a discussion of oscillations in exponential decay of ^{32}Si in the measurement by 1986Al10. Specific activity methods for half-life measurement: 1993Ch10: source from implantation of separated projectile (^{40}Ar beam) fragments into an inert collector, decay equilibrium technique, two independent samples. Authors quote an average result as 132 y *13*. 1991Th06: source produced by ^{18}O(^{16}O,2p) reaction. ^{32}Si/^{31}Si abundance ratio using AMS (accelerator mass spectrometry), and β scintillation spectrometry. 1990Ho27: source produced by ^{37}Cl(p,X) and ^{31}P(n,p) reactions. ^{32}Si/Si abundance ratio by AMS, and β spectrometry. Three independent samples. 1980Ku11: source from ^{30}Si(t,p), AMS technique and β-scintillation spectrometry. 1980El01: source from Cl(p,X), AMS technique and β-scintillation spectrometry.

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Yu. Khazov, A. Rodionov and G. Shulyak	NDS 136, 163 (2016)	14-Jul-2016

Q(β^-)=−3879 *6*; S(n)=8416.3 *29*; S(p)=7018 *4*; Q(α)=2528.8 *28* 2012Wa38
Produced and identified by 1953Du21, irradiation of Nd target by 40 MeV ^{4}He.
The ^{146}Sm scheme is built on the basis of data on ε decay and in-beam reaction study. It contains more than 210 levels and about 500 γ transitions. Six Eγ energies differ greater than 3σ from corresponding level energy differences, they were not taken in to account in a least-square fitting. Band sequences are from 1995Ba57.

^{146}Sm Levels

Cross Reference (XREF) Flags

A	^{146}Pm β^- decay	F	^{144}Sm(t,p)
B	^{146}Eu ε decay	G	^{147}Sm(d,t)
C	^{150}Gd α decay	H	^{147}Sm(^{3}He,α)
D	^{139}La(^{11}B,4nγ)	I	^{148}Sm(p,t)
E	Nd(α,xnγ)		

E(level)[†‡]	J$^\pi$	T$_{1/2}$[#]	XREF	Comments
0.0[@]	0$^+$	6.8×10^7 y *7*	ABCDEFGHI	%α=100 T$_{1/2}$: from 2012Ki16. Others: 5×10^7 y (1953Du21), 7.4×10^7 y *15* (1964Nu02), 10.26×10^7 y *48* (1966Fr11), 8.5×10^7 y *12* (1963Fr06), 10.31×10^7 y *45* (1987Me08). Observed α decay with Eα=2455 *4* (1987Me08), 2460 *20* (1964Nu02), 2550 *30* (1966Fr11), 2550 *50* (1960Ma39, 1953Du21), retardation factor=0.34 (1993Bu09). Isotope shift, mean square radii differences (2013An02 (compilation nuclear radii of Z=0-96), 1999GaZX, 1990En01, 1986Al33).
747.174[@] *11*	2$^+$	≤7.2 ps	AB DEFGHI	J$^\pi$: 747.2γ E2 to 0$^+$; assigned to level sequence built on g.s., 0$^+$.
1380.301[&] *15*	3$^-$		AB DEf h	XREF: f(1387), h(1376). J$^\pi$: 633.1γ E1 to 2$^+$; direct population in ^{146}Eu ε decay (Jπ=4$^-$); bandhead of one octupole phonon coupled level sequence.
1381.287[@] *14*	4$^+$	≤9 ps	B DEfGhI	XREF: f(1387), h(1376). J$^\pi$: 634.1γ E2 to 2$^+$; direct population in ^{146}Eu ε decay (Jπ=4$^-$); assigned to level sequence based on g.s.
1647.980 *14*	2$^+$		B EFGHI	J$^\pi$: 1648.0γ E2 to 0$^+$, 791.1γ from 4$^+$.
1792 *2*			G	J$^\pi$: from L(d,t)=3,5.
1811.674[@] *18*	6$^+$	0.09 ns *+10−5*	B DEFGHI	XREF: H(1820). J$^\pi$: 430.4γ E2 to 4$^+$, 986.0γ E3 from 9$^-$; assigned to the level sequence based on g.s.
1913 *2*			G	
2024 *2*			G	
2045.715 *16*	4$^-$		B E G	J$^\pi$: 665.4γ M1+E2 (ΔJ=1) to 3$^-$; direct population in ^{146}Eu ε decay (Jπ=4$^-$).
2083.432[&] *15*	5$^-$		B DEFGHI	J$^\pi$: 271.7γ E1 to 6$^+$, 702.1γ E1 to 4$^+$.
2155.824 *16*	2$^+$		B EFGHI	J$^\pi$: 2155.8γ E2 to 0$^+$, 1470.2γ from 4$^+$. L(d,t)=0 is incompatible with the J=2$^+$ assignment.
2211 *1*	0$^+$		I	J$^\pi$: from L(p,t)=0.
2222.438[c] *24*	6$^+$		B DE g I	XREF: g(2224). J$^\pi$: 410.8γ M1+E2 (ΔJ=0) to 6$^+$, 820.7γ E2 from 8$^+$. Bandhead of level sequence with ΔJ=1.

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	E. A. Mccutchan	NDS 126, 151 (2015)	1-Feb-2015

Q(β^-)=702 *3*; S(n)=6648 *3*; S(p)=5760 *3*; Q(α)=2023 *3* 2012Wa38
S(2n)=14478 syst *52*; S(2p)=13174 *3* (2012Wa38).
Other reactions:
^{9}Be(^{208}Pb,Xγ): 2002Pf01, 2012My01.
^{154}Sm(^{40}Ar,^{14}N): 1983Va10.
^{169}Tm(^{16}O,X): 2011Ya17.
^{179}Ta(n,γ): 1999Sc26.
^{180}Hf(p,n): 1977NoZU, 1981NoZX, 1982No09, 1985BaZA, 1986Ba84, 1987Ra23, 1989LaZS, 2011Ta22.
^{180}Ta(n,n′), ^{180}Ta(n,n′γ): 1975HaYR, 1999Ka03.
^{180}Ta(p,p′), ^{180}Ta(α,α′): 1986Is04, 1997Sc18, 1998Sc36.
^{180}W(n,p): 1975Qa01, 1983Ca23.
^{181}Ta(e,e′n): 1975Ra39.
^{181}Ta(π^+,p), (π^-,p): 1977Ja10, 1977Ja15, 1977ZiZZ, 1980Do07, 1980Mc03, 1981Mc09, 1998HuZY, 1998ZhZJ.
^{181}Ta(n,2n): 1968Bo25, 1969Br01, 1972Mo15, 1973ArZI, 1977Ve07, 1975FrZW, 1975FrZT, 1974FrZG, 1978Da24, 1979Mi11, 1980Mc03, 1980Ry02, 1980Se07, 1981La09, 1982Lu07, 1983AdZY, 1985Lu07, 1985Fa09, 1987Lu05, 1989Pe04, 1989Sc20, 1996Si34, 1999ZhZY, 2007Sh15, 2009Lu09, 2011Zh26, 2011Sv02.
^{181}Ta(pol p,p), (pol p,d): 1978WiZD.
^{181}Ta(p,np): 1971DuZQ, 1973CaXK, 1984Ab05, 1988Ba83.
^{181}Ta(^{15}N,^{16}N): 1966Ar17, 1972Ar35.
^{181}Ta(^{16}O,^{17}O): 1977Vi02, 1982Ma08.
α: Additional information 1.

^{180}Ta Levels

Cross Reference (XREF) Flags

A	^{180}Hf β^- decay (5.53 h)	E	^{180}Hf(^{238}U,Xγ)	I	^{181}Ta(p,d)
B	^{176}Yb(^{11}B,α3nγ),(^{7}Li,3nγ)	F	^{180}Ta(γ,γ′): target=9$^-$ isomer	J	^{181}Ta(d,t)
C	^{179}Hf(α,t),(^{3}He,d)	G	Coulomb excitation		
D	^{180}Hf(p,nγ),(d,2nγ)	H	^{181}Ta(γ,n)		

E(level)†	J$^\pi$	T$_{1/2}$‡	XREF	Comments
0.0^a	1$^+$	8.154 h *6*	ABCD F HIJ	%β^-=15 *3*; %ε=85 *3* %β^-,%ε: deduced by evaluator from β^-/ε=0.15 *2* (1962Ga07), β^-/ε=0.221 *14* (1980Ry01), and β^-/ε=0.18 *3* (1974HeYW). J$^\pi$: J=1 from log *ft*=5.97 to 2$^+$ and log *ft*=5.71 to 0$^+$ in ε decay to ^{180}Hf. π from L(d,t)=L(p,d)=4. T$_{1/2}$: weighted average of 8.152 h *6* (1980Ry01), 8.15 h *3* (1999Be65), and 8.18 h *2* (2002Be18). Others: 8.00 h *5* (1950Wi67), 8.15 h *2* (1951Br87), 8.15 h *5* (1962Be52), 8.19 h (1962Fo10), 8.1 h *1* (1963Ra14), and 7.99 h *5* (1968Bo25). configuration=π7/2[404]ν9/2[624].
39.54^a *5*	2$^+$		BCD HIJ	J$^\pi$: 40γ to 1$^+$, band assignment; π=+ from L(d,t)=L(p,d)=4.
77.2^o *12*	9$^-$	>7.1×10^{15} y	ABCDEFG I	Q=+4.95 *2*; μ=4.825 *11* E(level): weighted average of 78.0 *10* from ^{181}Ta(p,d) (2002We01) and 75.5 *14* from the difference between the ^{181}Ta neutron separation energy (S(n)=7576.8 keV *13*) (2012Wa38), and the neutron thermal capture-state energy of 7652.3 keV *5* (from ^{180}Ta(>7.1×10^{15} y)(n,γ)) (1981Co17). Other values: 73 keV *2*, using S(n)=7579 keV *2* from ^{181}Ta(γ,n) (1981Co17); 77 keV *9*, from mass doublets measurements (1980Sh06); 82 keV, from (α,t) (1983Wa01).

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Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 132, 1 (2016)	4-Dec-2015

$Q(\beta^-)=-1339$ *5*; S(n)=8744 *4*; S(p)=5517.5 *3*; $Q(\alpha)=178.6$ *8* 2012Wa38

^{157}Tb Levels

Theory and model calculation of interest: Nilsson level energies (1975Ni03, 1973Wi22, 1990Na14); configurations for bandheads (1972So12, same results are in 1973Ga29 and 1971SoZW, 1985AlZO); parameters for ground-state rotational band (1975Jo01); level energies in rotational bands (1978Al14, 1990Ha37); yrast states (1979KeZV); and E1 transitions (1973Wi02, 1993Ne10).

Assignments to the 1/2[541] band and a 1/2[411] band fragment are not adopted here, but are discussed in the levels from the ^{156}Gd(^{3}He,d) reaction.

No band parameters are given for 5/2[532] band because it is highly distorted; if A and B are computed, the A value is negative. This distortion is due to mixing with the 7/2[523] band.

Additional information 1.

Cross Reference (XREF) Flags

A	^{157}Dy ε decay	D	^{157}Gd(d,2nγ),^{157}Gd(p,nγ)
B	^{154}Sm(^{7}Li,4nγ)	E	^{158}Tb(p,d)
C	^{156}Gd(^{3}He,d),^{156}Gd(α,t)	F	^{159}Tb(p,t)

E(level)†	J$^\pi$‡	$T_{1/2}$	XREF	Comments
0.0#	3/2$^+$	71 y *7*	ABCDEF	%ε=100 μ=+2.01 *2*; Q=+1.40 *8* J$^\pi$: From L=0 for (p,t) on 3/2$^+$ target and band assignment from comparison of measured and calculated cross sections for (^{3}He,d) and (α,t) reactions. $T_{1/2}$: From $T_{1/2}(\varepsilon_K)$=455 y *40* (1983Be42) and $\varepsilon_K/\varepsilon$= 0.157 *7*, corresponding to the adopted Q value of 60.04 *30*. 1983Be42 deduce $T_{1/2}$=99 y *10* using $\varepsilon_K/\varepsilon$=0.218, corresponding to a Q value of 62.9 *7*. Others: 150 y *30* (1964Fu03), 160 y *40* (1963Iw04), and 280 y *120* (1964Gr14). 1983Be42 suggest that the latter values need to be corrected for capture to higher (i.e., M, O, etc.) shells, and that the corrected values are 100 y *20* (from 1964Fu03 value) and 220 y *95* (from 1964Gr14 value). μ: from 2011StZZ compilation and based on measurement of 1990Al36 by collinear fast beam laser spectroscopy; other: 2.0 *1* from electron-paramagnetic-resonance measurement (1968Ea04). Q: from 2011StZZ compilation and based on measurement of 1990Al36 by collinear fast beam laser spectroscopy. RMS charge radius <r^2>$^{1/2}$=5.0489 fm *1500* (2013An02).
60.881@ *3*	5/2$^+$	0.49 ns *12*	ABCDEF	J$^\pi$: from M1+E2 γ to 3/2$^+$ level and band structure. $T_{1/2}$: from ^{157}Dy ε decay (1972Af03); other: < 0.42 ns (Muminov, thesis, Dubna, 1978 as cited in 1997Ad08). 1997Ad08 suggest that the 1972Af03 value is too large.
143.921# *6*	7/2$^+$		ABCDEF	J$^\pi$: From M1+E2 γ to 5/2$^+$ level, E2 to 3/2$^+$, and band structure.
252.58@ *6*	9/2$^+$		ABCDEF	J$^\pi$: From band structure and (^{3}He,d) and (α,t) data.
326.346& *6*	5/2$^-$	0.20 ns *4*	AB D f	XREF: f(325). J$^\pi$: From E1 γ's to 3/2$^+$ and 7/2$^+$ levels. $T_{1/2}$: The five reported values form two groups each of which is internally consistent, but the groups are inconsistent. The adopted value is from 1967Ma33; and the values that are consistent with it are <0.25 ns (1966Me06) and ≤0.23 (1972Af03). The average of the other two values is 0.34 ns *4* from 0.33 ns *4* (1967Ko17) and 0.41 ns *9* (1967Ha12). If the three actual values are averaged,

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Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, Balraj Singh and John A. Cameron	NDS 112, 2357 (2011)	31-Jul-2011

Q(β^-)=−1.343×10^4 *19*; S(n)=16299 *8*; S(p)=8649.4 *20*; Q(α)=−5127.1 *7* 2012Wa38

Note: Current evaluation has used the following Q record.

S(2n)=28586.5 *8*, S(2p)=13579.2 *7* (2011AuZZ). Values in 2003Au03: S(2n)=28570 *5*, S(2p)=13579.3 *7*.

Q(β^-)=−1.343×10^4 *12*; S(n)=16299 *7*; S(p)=8649.4 *20*; Q(α)=−5127.1 *7* 2011AuZZ,2003Au03

Other reactions:

Preparation of ^{44}Ti radioactive target: 1999La11.

Additional information 1.

^{12}C(^{32}S,F),(^{32}S,X)E=140 MeV: fission of ^{44}Ti: 1986Pl02 (E=140 MeV), 1979Os01 (E(c.m.)=20-35 MeV).

^{16}O(^{28}Si,^{28}Si): resonances: 1979Ba49 (E(c.m.)=30.0-32.7 MeV).

^{24}Mg(^{32}S,^{12}C) E=140 MeV: fission fragments: 1990Sa14; E=164 MeV: γ-ray spectroscopy: 2000Th16.

^{40}Ca(α,α): resonances: 1984Ch15, 1976Fr08. See ^{40}Ca(α,α) dataset.

^{40}Ca(^{16}O,^{16}O): resonances: 1984Me01 (E=18.67-22.29 MeV).

^{40}Ca(^{32}S,^{28}Si): α-particle transfer: 1989Di06 (E=90, 100, 110 MeV).

^{44}Ca(π^+,π^-): double-charge exchange reaction: 1979Da16 (E=290 MeV), 1987Gi04 (E=163,210 MeV), 1987Zu03 (E≈292 MeV), 1988We02 (E=35 MeV), 1990Se11 (E=100-300 MeV), 1990We05 (E=35 MeV), 1991Ba05 (E=50 MeV), 1991Wi03 (E=300-550 MeV), 1992Le16 (E=25-65 MeV), 1993Wa02 and 1993Wa30 (E=50 MeV), 1995Si01 (E=32-79 MeV).

Others: 1962Kl01, 1964Li13, 1964Ri02.

See ^{24}Mg(^{28}Si,2$\alpha\gamma$) for possible additional levels at 3417, 2$^-$ (2336γ); 7454, 8$^+$ (3444γ); 8984, 10$^+$ (2416γ); 9488, 10$^+$ (2920γ); 11498, 12$^+$ (2515γ); 11833, 12$^+$ (2849γ); 13782, 14$^-$ (3325γ). These levels are not confirmed in (^{24}Mg,2$\alpha\gamma$).

See ^{28}Si(^{24}Mg,2$\alpha\gamma$) for possible additional level at 11536 (1072γ, 3498γ). This level is not confirmed in (^{28}Si,2$\alpha\gamma$).

See ^{40}Ca(α,α) for about 35 resonances between 9068 and 12860-keV excitation.

See 1998Ya21 and 1998Mi33 for a very detailed review of α-cluster structure as deduced from ^{40}Ca(α,α) and (^{6}Li,d) reactions.

^{44}Ti Levels

Cross Reference (XREF) Flags

A	^{44}V β^+ decay (111 ms)	H	^{40}Ca(α,γ)	O	^{40}Ca(^{16}O,^{12}C)
B	^{44}V β^+ decay (150 ms)	I	^{40}Ca(α,α):resonances	P	^{40}Ca(^{20}Ne,^{16}O)
C	^{45}Cr εp decay (60.9 ms)	J	^{40}Ca(^{6}Li,d)	Q	^{40}Ca(^{32}S,^{28}Si)
D	^{24}Mg(^{28}Si,2$\alpha\gamma$)	K	^{40}Ca(pol ^{6}Li,D),(^{6}Li,pnγ)	R	^{42}Ca(^{3}He,n)
E	^{28}Si(^{19}F,2npγ)	L	^{40}Ca(^{7}Li,t)	S	^{42}Ca(^{16}O,^{14}C)
F	^{28}Si(^{24}Mg,2$\alpha\gamma$)	M	^{40}Ca(^{12}C,^{8}Be)	T	^{46}Ti(p,t),(p,tγ)
G	^{32}S(^{14}N,pnγ),^{42}Ca(α,2nγ)	N	^{40}Ca(^{13}C,^{9}Be),(^{14}N,^{10}B)		

E(level)†‡	J$^{\pi\&}$	T$_{1/2}$$^{\#@}$	XREF	Comments
0^e	0$^+$	59.1 y *3*	ABCDEFGHIJKLMNOPQRST	%ε=100 The charge radius (<r^2>)$^{1/2}$=3.6185 fm *38* (2004Ga34,laser spectroscopy). Evaluated (<r^2>)$^{1/2}$=3.611 fm *51* from 2008 evaluation by I. Angeli, available on http://cdfe.sinp.msu.ru. T$_{1/2}$: weighted average of 58.9 y *3* (2006Ah10,timing distribution of ratio of 1157γ from ^{44}Ti decay and 1173γ from ^{60}Co decay, weighted average of 8 measurements at Argonne and two at Hebrew university; earlier value from the same group is 59.0 y *6* (1998Ah03)), 59 y *2* (2001Ha21, specific activity method by counting implanted ^{44}Ti fragments and γ counting of individual and sum peaks), 60.7 y *12* (1999Wi01, time distribution of γ activity), 60.3 y *13* (1998Go05, specific activity method with γ counting), 62 y *2* (1998No06, time distribution of γ activity, preliminary value from

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